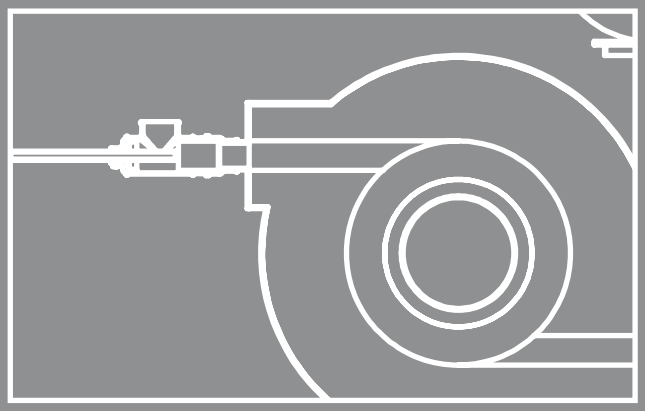
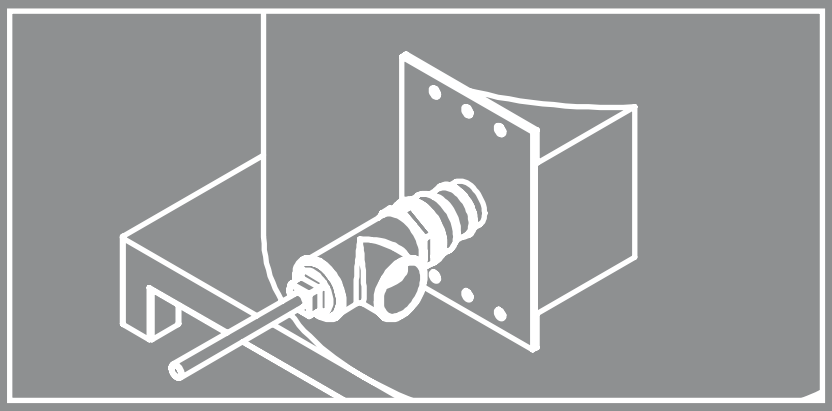
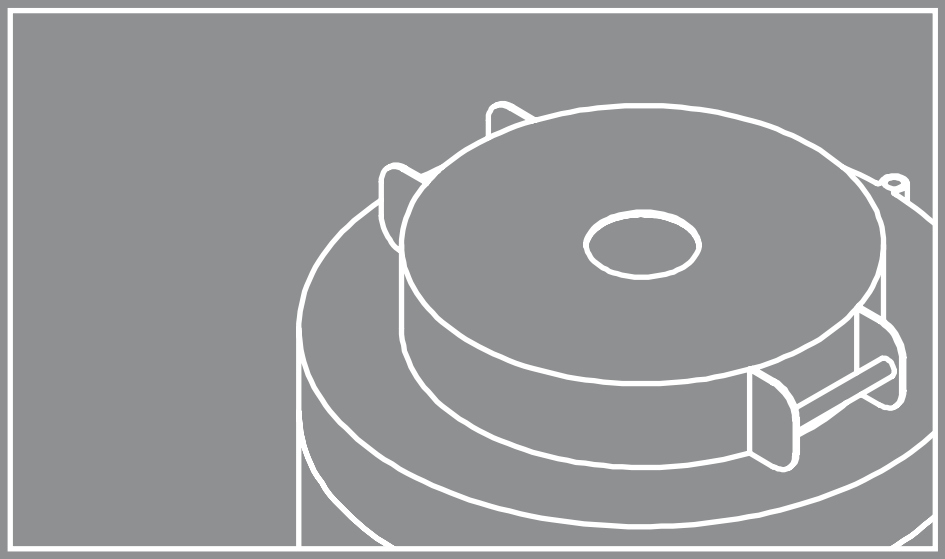
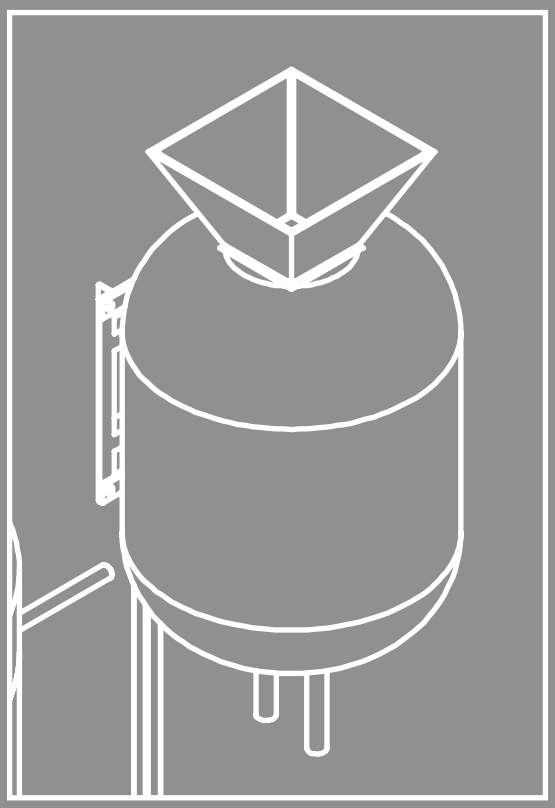




ALTERNATIVE FOUNDRY





Intoduction

Metal Casting Heritage

The process and craft of metal casting has a lineage dating back millennia. For most of that time the fuel used for furnace firing was charcoal. Although charcoal has a carbon footprint, it is produced from a sustainable material, wood.

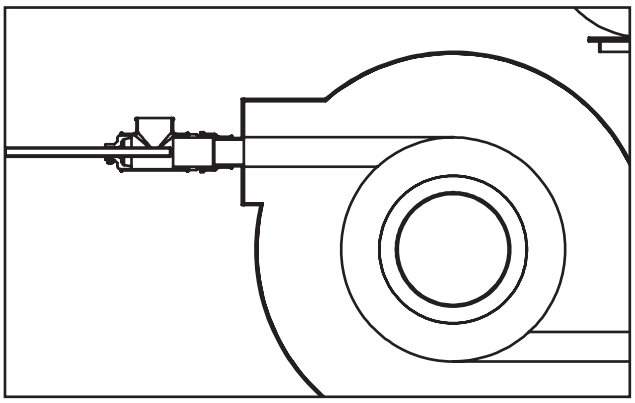
The industrial revolution bought the development of foundry coke and later that of propane gas superseding charcoal as a fuel. As coke and propane are derived from fossil fuels, they have a significant carbon footprint in both their production and use. These fossil fuels were adopted by the foundry industry and the arts sector for their respective ease of use and quality, although heavy industry has now moved toward melting metals using electric furnaces. These electro arc induction furnaces are much cleaner however, they are prohibitively expensive for smaller foundry operations.

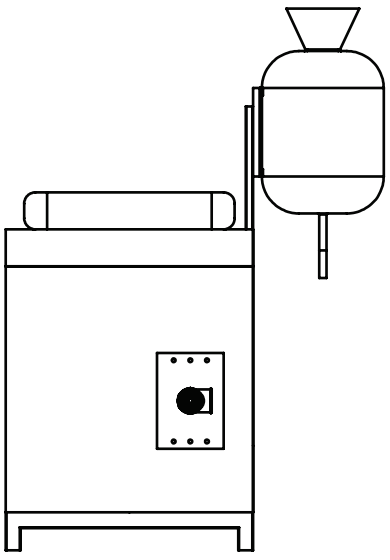
Coles Castings an artist run foundry and studio, was keen to develop and refine a simple adaptable system that utilised a sustainable fuel source. In this instance used vegetable/cooking oil to continue casting works in a range of metals for clients within the fine art and heritage sectors and as part of their own creative practice. They have successfully developed a simple, replicable crucible furnace capable of melting bronze and cast iron reliably in a cost-effective way. They are keen to share their research with institutions and practitioners who wish to address the issue of sustainability within the sector.

Acknowledgements

Coles Castings would like to thank ESW for embracing the project and for their help with the production and publishing of this article and hope that it will be of use to a broader community.

ESW's new furnace and set up was built in collaboration with Coles Castings who have been developing their Waste Oil furnace and foundry system as a viable alternative to use of bottled gasses, mined bituminous coke and associated fossil fuel sources.





Technical drawings of furnace and components by Calum Murray.

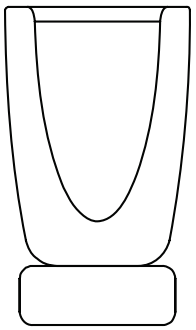
PDF Concept and Design by Aimee Finlay.

Furnace design by Stephen Coles and Necole Schmitz of Coles Castings.

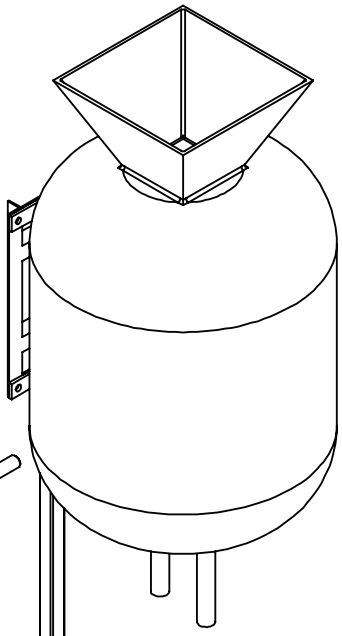
Writing by Stephen Coles and Stephen Murray

Components of the Metal Furnace

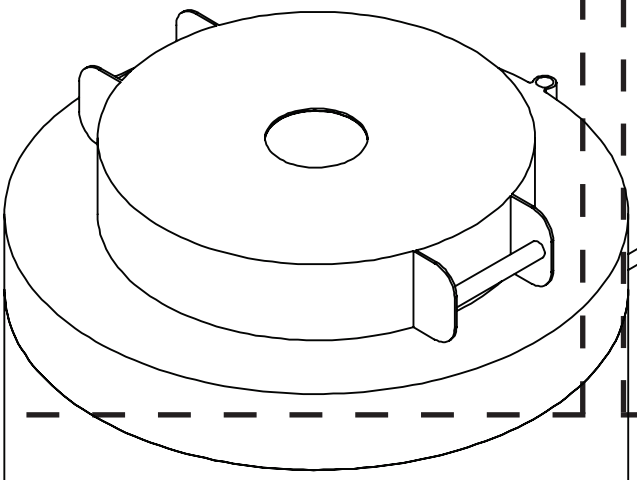
1 THE CRUCIBLE



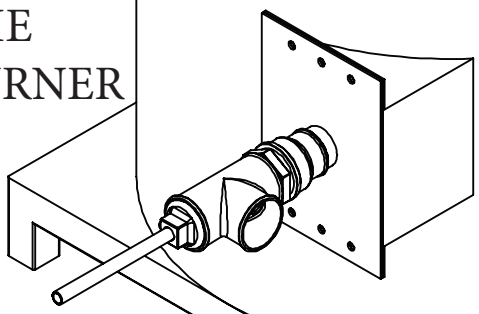
2 THE BIO-FUEL



3 THE TOP HAT, WALL & LID



4 THE BURNER



5 THE AIR SYSTEMS

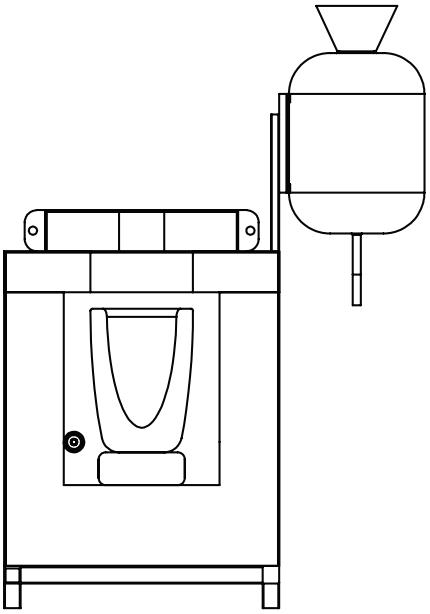
6 THE FURNACE

ALTERNATIVE FOUNDRY PRACTICE

1 THE CRUCIBLE

The role of the Cruicble

The crucible is the pot in which metals can be melted inside the furnace. These are commonly made from Silicon Carbide or Ceramic bonded Graphite. For Hi Temp Melts (such as ferrous) it is best to use Sil-Carb because of its ductility and resistance to thermal shock. The crucible is lifted out with steel tongs when metal is at the correct temperature, it is placed in a pouring shank, carried to and poured into prepared moulds.

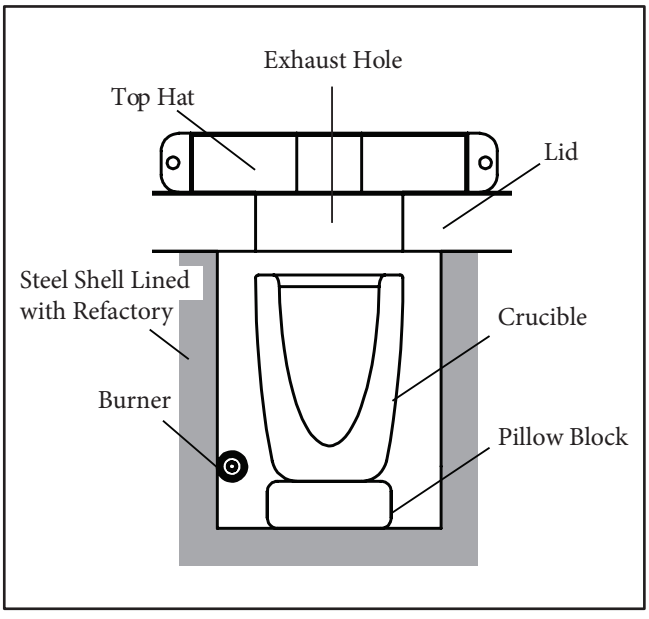


Maintenance of Crucible

As with all foundry operations the crucible is consumed over several pours and should be regularly checked for wear and tear (cracks, etc). It should be kept in a dry secure environment between pours to reduce any risk of damage.

Crucible size

Depending on the size of work you would like to produce; it is important to consider the size of crucible. This will ultimately determine the size of the furnace. Coles Castings main furnace employs a number A60 crucible which allows them to melt 60kg of metal. However, they also have a much smaller portable furnace which will hold a number A16 crucible allowing them to melt 16kg of metal. When less metal is needed for casting the smaller furnace has the advantage of using less fuel and has a shorter melt time. Additionally, smaller crucibles tend to be cheaper and as such overall running and operation costs are less. On the other hand, more sizeable work can be cast using a larger foundry setup. Both sizes have their pros and cons depending on one's creative practice.



2 THE BIOFUEL

Introduction to Alternative Fuel

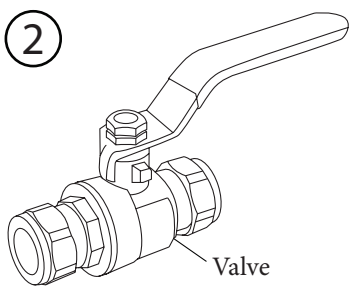
The Coles foundry system uses waste vegetable oil from the food industry as its fuel. It has been filtered to remove water and organic components allowing for a clear run to the burner ports. This removes unwanted materials and prevents clogs on the fuel lines. Waste vegetable oil is predominantly used in the manufacturing of Bio Diesel but with a little effort a supply can be found.

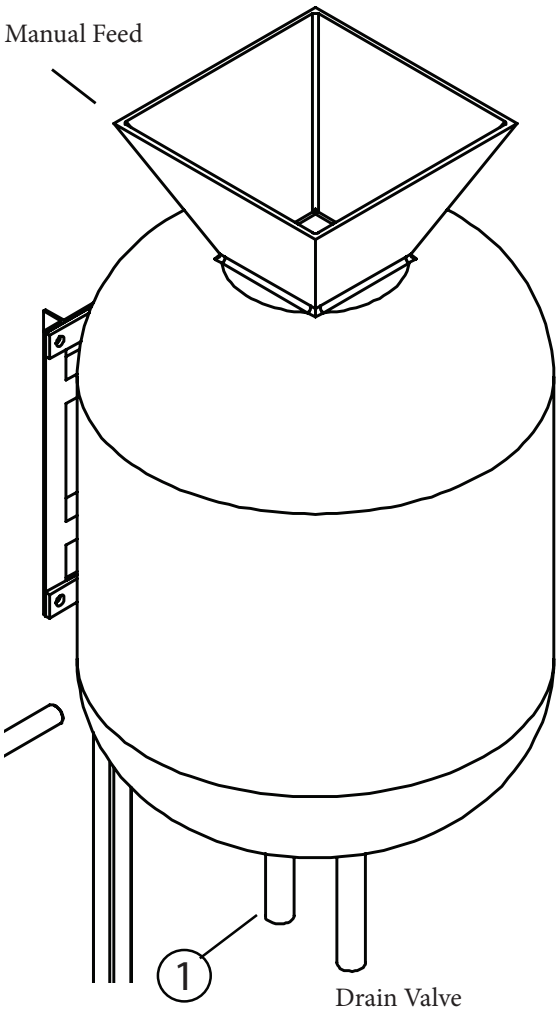
Vegetable oil is a Hydro-Carbon that is capable of high temperature combustion. Vegetable oil has a greater heat value than commercially available cylinder gasses allowing for the melting of higher temperature alloys such as cast iron. It is this quality that allows Coles Castings to successfully melt iron in the crucible which would not be possible in a standard gas fired crucible furnace.

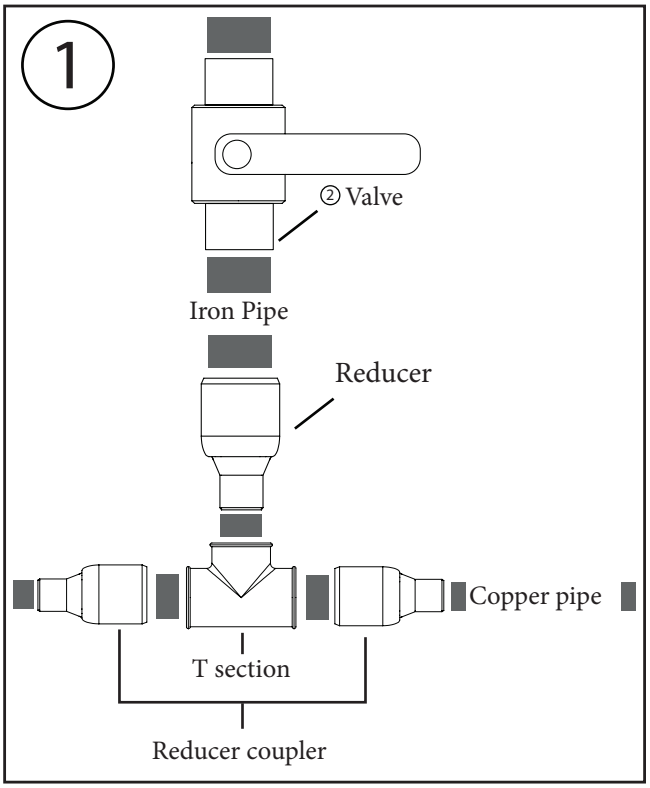
Vegetable oil is manufactured from Bio-Mass methods of production (growing and harvesting of plant material- seasonal) rather than the formation of Fossil Fuels (millennial). In general, they are regarded as a renewable source of energy with fewer greenhouse gases released at point of combustion. This is made more sustainable by using a post-consumer waste product, please see the HCA summary for details.

Assembly of the Oil Feed

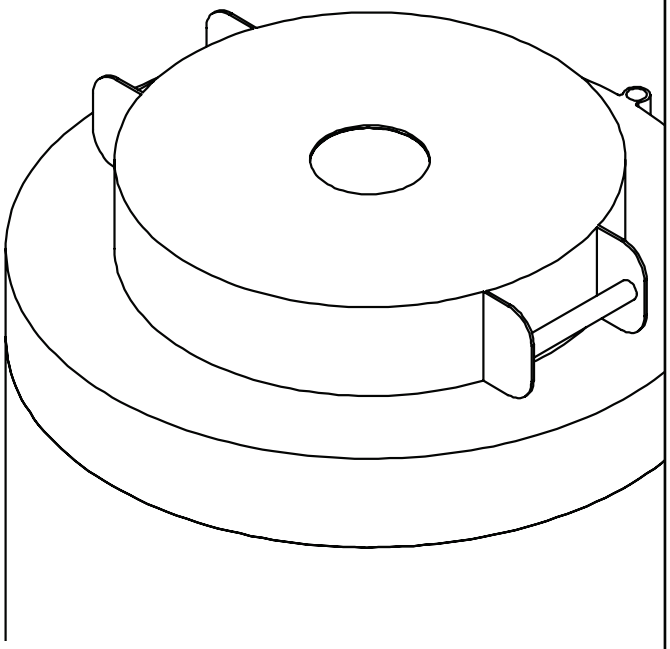
The oil feed to the burner ports runs from a gravity fed tank above the furnace. This provides oil to the two burner ports after splitting at a T-Section. The feed is controlled at each section with ball valves to regulate oil consumption. The oil is manually added to the tank when required during operation.







3 THE TOP HAT, WALL & LID



The Lining of the Top Hat, Wall & Lid

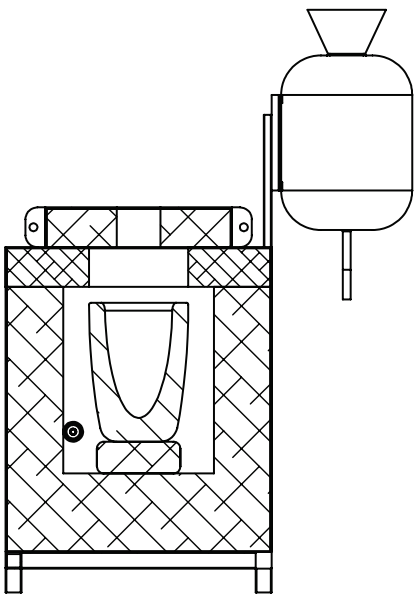
The furnace can reach the high temperatures required to melt ferrous metals in part due to the burners and vegetable oil fuel. However, the other necessary component to reach these temperatures is the furnace lining. Both the walls and lids are lined with a high refractory cement and a high temperature rammable clay body. Both materials are rated to withstand temperatures of up to 1500 degrees Celsius, this is about 100 degrees more than required.

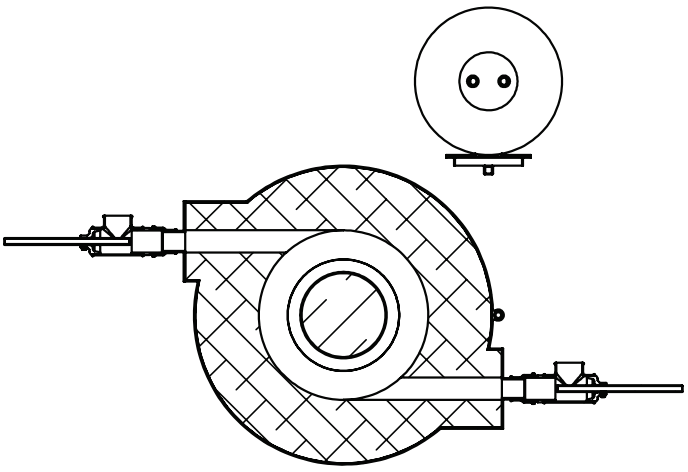
The role of the Top Hat

Additionally, a smaller lid that sits on top the main lid of the furnace called a 'top hat' this lid also aids in reaching high temperatures. The additional lid aids in the inspection and charging of the crucible whist conserving heat that would be lost when opening the main lid. The top hat design allows for charges of metal that are too large to fit through the exhaust to be added. The main lid can remain closed until we are ready to pour thereby preserving heat within the chamber as well as shielding the operator from the main heat of the furnace.

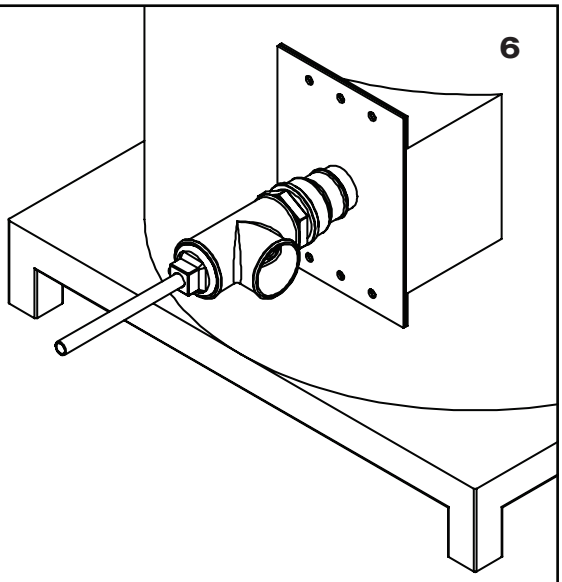
The role of the Lid

The lid is a critical component to the furnace, without which the furnace would not be able to contain enough heat within the system to melt the metal. Essentially it creates a chamber for the heat of the furnace. The exhaust in the top allows gases to escape, but otherwise reflects all the heat produced from the burners back into the chamber allowing for the high temperatures needed for the melt.





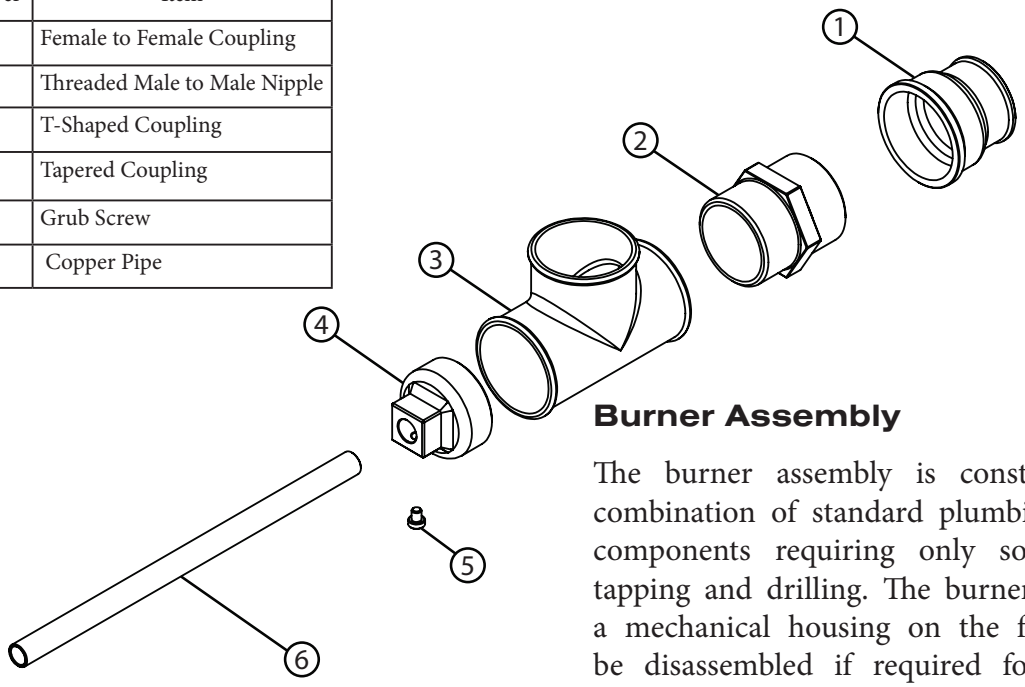
4 THE BURNER



The role of the Burner

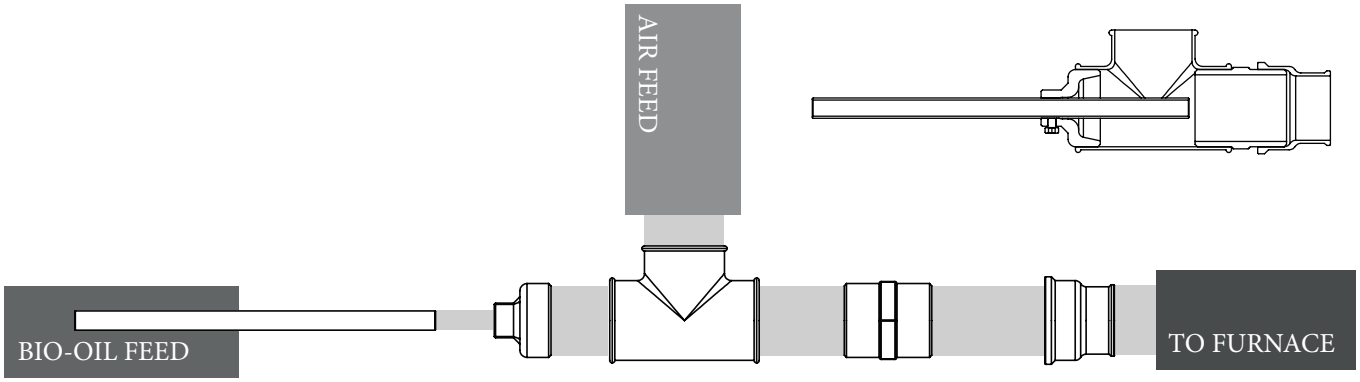
The Burners on the furnace provide a double feed set tangentially at the base of the furnace. The burners work in unison to create a stable atmosphere and to distribute the heat evenly through the main chamber of the furnace. This helps with the efficiency of the furnace as well as minimising stress on the crucible by ensuring that it is evenly heated throughout.

Number	Item
1	Female to Female Coupling
2	Threaded Male to Male Nipple
3	T-Shaped Coupling
4	Tapered Coupling
5	Grub Screw
6	Copper Pipe



Burner Assembly

The burner assembly is constructed from a combination of standard plumbing and heating components requiring only some machining, tapping and drilling. The burners are built into a mechanical housing on the furnace but can be disassembled if required for cleaning and inspecting.



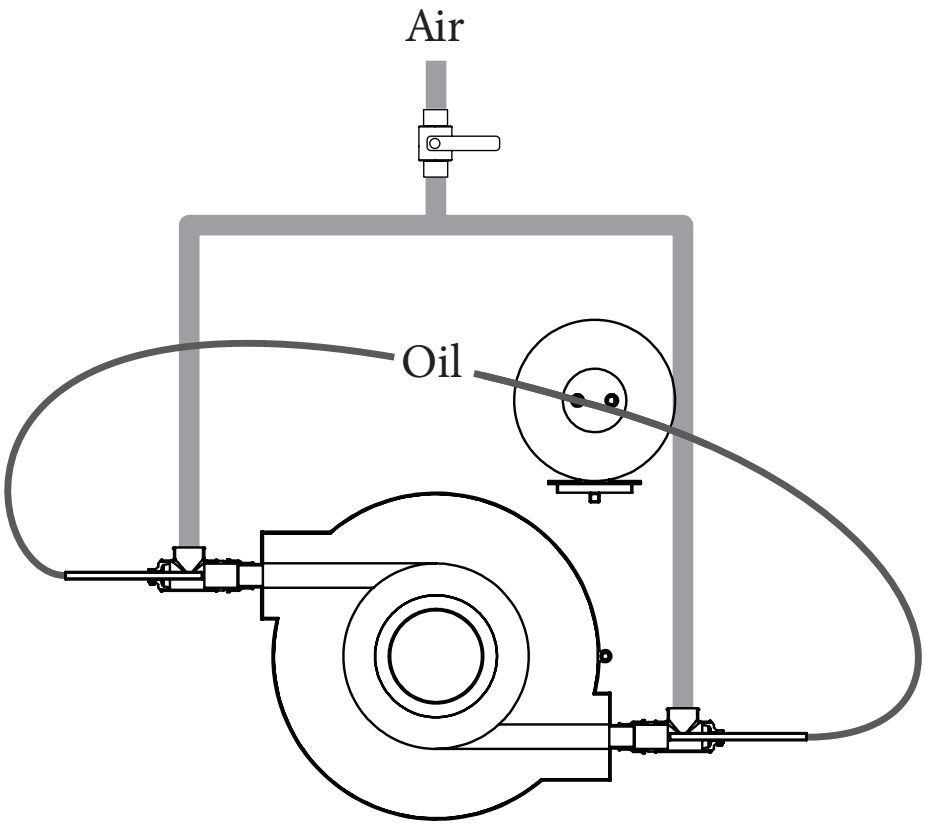
Fuel Oil Atomization

With the regulated forced air coming into the side of the burner the oil is gravity fed internally from the back via a steel pipe whose depth can be adjusted. Once the fuel is atomised it can be ignited from a kindling fire inside the furnace – much like igniting a diesel burning it take some minutes to bring up to temperature for combustion. Once ignited the fuel and air can be balanced throughout the running of the melt.

5 THE AIR SYSTEMS

The Role of Air

A blower provides the forced air source to the main blast pipe which runs to both the burners atomising the oil and providing oxygen necessary for combustion. This blast of air is controlled via a main valve located in front of the blower. This allows for the airflow to be adjusted to reduce the air when needed for inspecting the melt as well as charging the crucible and removing the crucible from the furnace to pour the metal.

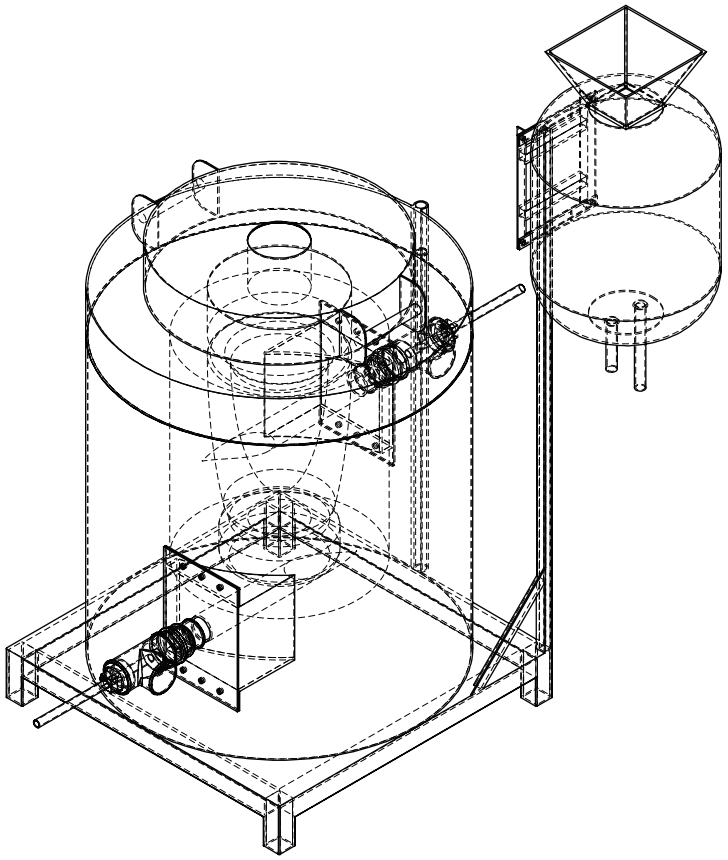


Assembly of Air System

Constructed from commercially available BSE connectors, couplings and joined to a standard blower. Some pipe components required threading from engineers.

6 THE FURNACE

Overview



The furnace is constructed from Mild Steel and High Temperature Refractory. Again, your crucible size determines the size the furnace and ironmongery components needed. Following Coles Castings self-reliant ethos only a basic range of metalworking tools (Mig welder, Cold Saw, Rollers, Grinders) is needed. In the case of some components such as the body of the furnace it may be prudent to approach an engineering firm to help with various parts of the fabrication that may be unrealistic in a small studio setting.

A rammable refractory was used to line the body of the furnace and is readily available and cost effective, a castable refractory can also be used if preferable. It is recommended that your lid and your top hat (second lid) be cast as opposed to rammed. A good refractory rated to 1500 degrees Celsius will suffice. A pillow block stand for the crucible was purchased allowing for safe operation of the crucible whilst housed in the furnace whilst in use.

Running the Furnance

Working on any hot process requires preparation, planning and detailed knowledge of your craft. If you lack experience working in foundry processes, we recommend you undertake training with an experienced practitioner before you begin. It is always useful to keep track of all your timings, temperatures and fuel consumption in a furnace firing log. This also creates a valuable record of information for your system which can help when trying to problem solve any issues you may have.

This system is operated in a similar way to a standard crucible furnace, however the increased heat from the combustion of the vegetable oil results in quicker melts than with a propane furnace. Be mindful you do not burn your metal, particularly if you are melting lower temperature alloys such as bronze. In general a crew of two to three trained personnel can operate the furnace safely and efficiently. As with all foundry operations, preparation and timing is key to success.